granules, merely as a minute fibrous network, or as films enveloping olivine cores, to that in which only minute particles of olivine survive as the nuclei of the granules, and to the final result of a true and complete serpentine."

Dr. Julien further claims, that the actinolites, amphibolites, hornblende schists, and many of the talc schists, steatites, and serpentines of the Appalachian belt, are the equivalents of the dunite of North Carolina.

The objections to some of Dr. Julien's views have not been offered from any spirit of criticism of his truly excellent paper, but for the purpose of causing a more thorough study of the field-relations of this rock, and a presentation of the evidence that study affords. If the evidence, then, sustains Dr. Julien's conclusions, his views will be accepted unhesitatingly. He has, indeed, given more evidence for his opinions than most writers on crystalline rocks are inclined to offer; for, as a rule, they appear to consider their mere dictum sufficient to prove the origin of any rock. It would seem that the time has come when statements regarding the origin of crystalline rocks cannot be accepted from *any* observer, unless these claims are accompanied by full and decisive proof of their correctness. To bring about this healthy state in the study of the North-American rocks, the present writer has labored for years, and will continue to labor. M. E. WADSWORTH.

ABOUT GREAT TELESCOPES.

DR. RALPH COPELAND of Dun Echt, near Aberdeen, when returning to Scotland by way of this country a few months since, made a tour of several North-American observatories; and in a late number of *Copernicus* he contributes a paper on the Dudley observatory at Albany, the Litchfield observatory of Hamilton college at Clinton, the Warner observatory at Rochester, the Toronto observatory (Canada), the McGill college observatory (Montreal), the Harvard college observatory (Cambridge), the Winchester observatory of Yale college (New Haven), the two observatories at Princeton, and the U.S. naval observatory (Washington). The noteworthy portions of the equipment of these establishments are briefly dealt with, and the work generally specified on which they are employed. Dr. Copeland, having enjoyed the good fortune of seeing through a number of the finest telescopes in all parts of the world, places on record, at the conclusion of the paper, his general impressions of the actual state of telescope-construction on both sides of the Atlantic.

First as regards their optical merits: it does not seem to him that any material difference as to the mere power of separating close double stars exists in the object-glasses made by the chief opticians in Europe and America. On a night of good definition, any of their telescopes may be trusted to divide a fairly equal pair of stars at a distance indicated by Dawes's table,[1] of which the following is a sufficient specimen: —

Aperture in inches.	Least separable distance.
1.0	4.56″
2.0	2.28
3.0	1.52
4.0	1.14
6.0	0.76
8.0	0.57
10.0	0.46
12.0	0.380
15.0	0.304
20.0	0.228
25.0	0.182
26.0	0.175
27.0	0.169
30.0	0.152

We thus see that in this respect our telescopes are practically perfect, and also that the atmosphere on the very best nights is sufficiently steady to permit their full power to be used. If, however, we test them on double stars, of which the components differ very much in brilliancy, then it is by no means so easy to come to a certain conclusion. There is the secondary spectrum to contend with, respecting the character of which it may be said that a certain degree of personal taste or fashion exists. Some persons, notably opticians, seem to be little disturbed by a decidedly blue glare, while others prefer a wine-colored fringe. Perhaps, indeed probably, there is a physiological difference in the observers; for, if we suppose a person to be blind to the extreme blue and the violet rays only of the spectrum, to him an over-corrected object-glass would be perfect. With it he would be able to make out the closest companions of blue stars, or to see comparatively faint ones right up to the moon's bright limb. To such a person, however, an object-glass under-corrected to the same extent would appear to be a decidedly bad one. To Dr. Copeland, as well as to many of his colleagues, an average glass by Cooke or Grubb, and, to a less extent, by Clark, appears over-corrected; while one by Schröder, and some of the Munich glasses, appear under-corrected. But here an important practical difference enters into consideration, one which has been particularly experimented on by Mr. Russell of Sydney; viz., that the correction of an object-glass may be lessened by separating the lenses: so that an over-corrected object-glass may be adjusted to any desired extent, while one that is under-corrected can only be used in the state in which it left the maker's hands. As an example, it may be mentioned that the somewhat over-corrected object-glass of the 15-inch equatorial at Dun Echt has been materially improved by separating its lenses 0.2 of an inch, while a separation of 0.3 of an inch was found to throw out too much red about the primary image. This degree of improvement is best shown by the extremely linear character of the spectra of stars which it now gives. But in this connection it is only fair to mention, that, in making this object-glass, Mr. Grubb was limited to the relatively short ratio of 12 to 1 between the focal length and aperture. Opticians have not neglected to avail themselves of this property; and

[1] Mem. roy. astr. soc., xxxv. 158.

accordingly we find three of the largest objectives in the world, — the 27-inch at Vienna, by Grubb; the 23-inch at Princeton, and the great Russian 30-inch, both by Alvan Clark & Sons, with their lenses separated by a considerable interval.

Assuming a large lens to be made of satisfactorily good disks, and having its curves and interval so adjusted as to give the best attainable results, there is another detail of construction which demands increased attention with every augmentation of size; i.e., the state of the surfaces of the lenses. Formerly it was too readily assumed, that, provided the curves were right, a few scratches more or less did not matter. There is a well-known story of an optician, who, on being blamed for turning out a badly scratched lens, replied that an object-glass was to be looked through, and not at. The optician was nevertheless in the wrong; for if delicate objects are under examination, no matter whether they are small companions of large stars, or minute satellites of bright planets, there can be no doubt that the finish of the objective plays a considerable part in their visibility. Nor is it merely necessary that the surfaces should be correctly formed and well polished: it is also requisite that they should be kept scrupulously clean, and, above all, free from grease, the slightest trace of which, when spread over a lens, must throw out irregular diffraction spectra, materially affecting the visibility of any small point of light in the neighborhood of a brilliant object. In this respect no practical astronomer should neglect to assure himself that an object-glass is really doing full justice to the maker.

Dr. Copeland's remarks on the mountings of large equatorials are especially pertinent. In America, he says, the mounting is just or barely sufficient to permit of a satisfactory use of the grand optical powers of their larger instruments; and no refined detail of auxiliary apparatus is attempted. On the continent we find the convenience of the astronomer studied in the most painstaking manner, and perhaps in no instruments in the world is this so carefully kept in view as in the finer German instruments. This is doubtless due in no small measure to the intimate relations which exist between the chief continental instrument-makers and practical astronomers; so that just that kind of apparatus is provided which experience has shown to be requisite. On the other hand, in the stability and rigidity of their mountings, the larger English and Irish instruments stand preeminent, while they year by year show a greater variety of really available subsidiary apparatus. Indeed, there can be little room for doubt that the elder Grubb, by his elegant arrangements for relieving the friction of both axes of the equatorial mounting, practically removed all limits to its size and strength; while in the little-known 25-inch refractor at Gateshead, by Cooke & Sons, we have a telescope which only requires to be efficiently used in a good atmosphere to show its great merits in all respects.

Finally, Dr. Copeland thinks, that whether we take large European or American instruments, the prospect is most encouraging, both to the astronomer and the instrument-maker. Nowhere can signs be detected that the utmost practical limit has been reached. A 27-inch glass can be managed with probably greater facility now than a 10-inch fifty years ago, and with something closely approaching to the full gain in power, due to increased size. The question of size now, as it did then, reduces itself to the production of suitable disks of glass and to cost. Here it is that silvered-glass reflectors offer facilities of which several distinguished investigators have not been slow to avail themselves.

ENTOMOGRAPHY OF HIRMONEURA.

Dr. Friedrich Brauer has, during the past season, been able to add considerably to our knowledge of the life-history of the Hirmoneura obscura, and the results of his observations have been published (*Sitzungsb. akad. wiss. Wien*, p. 865). During the latter part of June he found within the nearly formed pupa of Rhizotrogus the second larval stage of the Hirmoneura, which resembles the first stage in the structure of the mouth-parts (see *Science*, No. 12), but lacks the pseudopods and ambulatorial filaments so characteristic of that stage. How and when the young Hirmoneura larva gets at the Rhizotrogus larva still remains unknown; but Brauer assumes (and I think he is quite safe in doing so) that it enters the larva (not the pupa) of the Rhizotrogus, and is a true parasite, and not merely a predaceous insect. Having entered the Rhizotrogus larva, it seems highly probable that the Hirmoneura larva has to undergo a kind of quiescent larval state of uncertain duration, but which suddenly changes to one of rapid development during the pupal state of the beetle, which lasts only from two to three weeks. Hirmoneura larvae in the second stage, of about eleven millimetres in length, were found in Rhizotrogus pupae; and ten days afterward the full-grown parasitic larva, twenty-two millimetres in length, was found. Brauer thinks it more than probable that the full-grown Hirmoneura larva, after emerging from the Rhizotrogus pupa, hibernates; the perfect fly appearing in July of the next year. This seems to me more doubtful. The Rhizotrogus larva is known to require two years for development. There are two alternatives for the Hirmoneura larva: either it is carried, by clinging to the beetle, into the ground, and remains quiescent, either attached to or near the Rhizotrogus larva, for nearly two years; or it is capable of independently discovering the Rhizotrogus larva when this last is in its second year's growth. The first seems to me the most probable, and would give two years for the development of the Hirmoneura, or even three if the full-grown larva hibernates. In either case, the young Hirmoneura larva is endowed with a sense which is truly marvellous, whether we choose to attribute to it consciousness of its acts, or ascribe them to 'blind instinct.'

Brauer raises a curious practical question, which would indicate that old pine fences or felled trees in a field may, in this particular case, serve to prevent the undue multiplication of the Rhizotrogus 'white grub.'

C. V. Riley.